BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

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SUBJECT: Provision of a Closed Circuit Television Capability On-Board the AAP Orbital Assembly - Case 620

DATE: September 15, 1969

FROM: A. G. Weygand

ABSTRACT

Possible implementation of a closed circuit television capability in the Orbital Assembly (OA) to permit a crew member to view remote scenes on board the OA is discussed using equipments and systems currently planned for incorporation in the OA. The portable color television camera carried to generate video signals for transmission to Earth from the OA could be used to generate the video signals for a closed circuit television system. A small black and white monitor which is included as part of the portable camera and used as a camera pointing aid can be separated from the camera and could be used as a monitor for the closed circuit television system. Alternatively, the monitors of the closed circuit television system of the Apollo Telescope Mount (ATM) could be used to display the images viewed by the portable camera. However, an interface circuit would have to be developed to extract the sync pulses from the video signal output of the portable camera before the signal is routed to the ATM television monitors and to generate the necessary horizontal and vertical drive signals required by the ATM monitors. In either case, additional pre-installed coax cable runs would be required.

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MEMORANDUM FOR FILE

The Orbital Assembly (OA) of the Apollo Applications Program (AAP) will be provided with the capability to transmit, in real-time only, video signals generated by either a portable television camera or any one of the cameras of the closed circuit television system of the Apollo Telescope Mount (ATM). The video signals from either of these two sources, but not both simultaneously, will be transmitted from the OA to the Unified S-Band (USB) stations of the Manned Space Flight Network (MSFN) via the S-band FM transmitter of the USB system of the Command and Service Module (CSM). Pre-installed wiring will be provided in the OA to permit the portable camera to be used at locations in the CM, in the Multiple Docking Adapter (MDA), in the crew quarters of the Orbital Workshop (OWS), and in the forward tank area of the OWS and to permit routing of the video signals from the closed circuit television system of the ATM to the CSM. A manually operated coax switch will be provided in the MDA or Airlock Module (AM) to select which of the three portable camera position locations in the MDA/OWS or the ATM closed circuit television system or none of these would be connected to the CSM S-band FM transmitter through the hardwire CSM/MDA interface. Individual coax cables will be routed from the coax switch location to each of the three possible portable camera locations in the MDA/OWS and to the ATM television system. It should be noted that the portable camera will be provided with a cable of sufficient length to enable a crewman to obtain the required camera coverage of areas in the vicinity of the three portable camera location disconnects.

The portable camera to be used for this application will be a refurbished color television camera from the Apollo Program of the type used during the Apollo 10 mission. This camera includes a small black and white monitor. The output of this camera will meet the standards for black and white television signals contained in Electrical Industries Association (EIA) Standard RS170. Color is obtained by using a different colored filter (total of three) in front of the camera tube during each field for three successive fields followed by appropriate processing on Earth after reception of any three successive fields. The cameras used in the closed circuit

television system of the ATM also provide a standard commercial EIA (525 line, 2:1 field interlace, 30 frames per second) format video signal output; however, synchronization pulses are not included in the signal. Redundant sync generators are provided in the ATM television system to distribute horizontal and vertical drive signals to each television camera and both monitors of the system for synchronization. Consequently, a sync adder will be required to change the horizontal and vertical drive signals into sync pulses and add them to the video signal from the selected ATM television camera before this signal is routed to the CSM for transmission to Earth.

In the current planning for the OA television system, there is no requirement for delayed video transmissions nor is there a requirement for on-board closed circuit television when the portable camera is being used. Because most of the elements for a closed circuit television system are present in the OA, a brief discussion on the possible implementation in the OA of an on-board closed circuit television capability when using the portable camera is presented in the subsequent portions of this memorandum. The discussion is based on the use of currently planned on-board OA equipments and systems to the maximum extent possible to provide this capability. Only the possible use of the monitor of the portable camera, the monitor of the ATM closed circuit television system, or both is discussed. Of course, it is recognized that television monitors of the type developed for use in on-board aircraft applications could be adapted and qualified for use in space in this non-mission-critical closed circuit television system application if larger or more monitors are needed.

As stated earlier, the portable camera will include a black and white monitor, although to date, its primary function has been to serve as a view finder in the camera's applications with a zoom lens in the Apollo Program. This monitor can operate attached to or separated from the camera. It weighs less than 4 pounds, requires approximately 3 watts of power, has a black and white screen measuring 2 x 2.75 inches, and has four operating controls (brightness, contrast, horizontal, and vertical). This monitor is a high impedance device. The input leads to this monitor are bridged across the output leads of the television camera so that the output signal from the camera will be routed in parallel to the monitor and the CSM S-band FM transmitter. A 75 ohm coax cable is used to provide this connection between the output of the camera and the input of the monitor. It should be noted that, unless appropriate processing of the video signal output of the portable camera is provided as is provided on Earth, the image produced on this monitor or any other monitor which

might be used will appear to the viewer to flicker or flutter because of the difference in content between successive fields caused by the use of different colored filters in the camera as discussed earlier.

To provide a closed circuit television capability on-board the OA using the portable camera, it is proposed that a second coax cable network be pre-installed in the OA. If a high impedance monitor were used and the coax cable carrying the camera output video signal to the CSM S-band FM transmitter were routed near the desired monitor location(s), a video signal of sufficient magnitude to drive the monitor without additional amplification could be obtained by tapping this cable. Hence, a second coax cable network would not be necessary. However, to maintain system flexibility, addition of a second coax cable network appears warranted. The second coax cable network would include a pre-installed coax cable and disconnect at each of the planned portable camera operating position locations. These cables would be routed to a coax switch located in the AM where the selection could be made as to which of these cables would be connected to a monitor location. The coax connecting the coax switch with the monitor location, or possible locations, would also be pre-installed. The output of the camera normally routed to the camera monitor would instead be routed via coax cable from the camera to the second disconnect.

Cable lengths of up to 10 feet have been used between the camera output and the monitor without significant degradation of the overall video link. Preliminary test results show that coax cable lengths of up to 25 feet can be tolerated. It is anticipated that coax cable lengths significantly greater than 25 feet will result in a shunt capacitance on the output of the portable camera of sufficient magnitude to cause ringing of the video signal and/or to cause other types of related signal degradation which could destroy the quality of the video signal transmitted to the MSFN. Tests are needed, however, to determine the exact effect on the camera video output produced by various lengths of bridged coax cable exceeding 25 feet. Pending the results of these additional tests, it appears likely that a high input impedance isolation amplifier would be required to maintain the shunt capacitance introduced by the tap on the output of the camera within acceptable limits for proper system operation. This amplifier should be located in or on the portable camera, if possible, or in the coax cable used to connect the output of the camera directly to the monitor as in current operation or to the second pre-installed coax cable in the proposed closed circuit television system application.

The small black and white monitor of the portable camera could be detached from the camera and used as the closed circuit television system monitor in any of the remote locations chosen in the OA. It is assumed that the zoom lens would remain at or very near its widest field of view and that the camera would be stationary during its applications inside of the OA when closed circuit television would be desired. As a consequence, the monitor would not be required at the location of the camera to provide fine pointing information to the crewman operating the camera and could be diverted for use in a closed circuit television system application. It is the opinion of the writer that the only applications of such a closed circuit television system on-board the OA which could possibly have justification other than on a "nice to have" basis are monitoring an unoccupied area for possible indications of trouble or monitoring a crewman while performing a task of mutual crew interest when unaccompanied by a second crewman. In both of these cases, the monitor would not be required for camera pointing application after the camera had been initially positioned. If a monitor were required exclusively for pointing the portable camera, a second black and white monitor of the same type refurbished after use in the Apollo Program could be carried for use in a closed circuit television system or one of the monitors of the ATM closed circuit television system could be used to display images seen by the portable television camera.

Such an application for a monitor of the ATM closed circuit television system would have some impact on the existing ATM system. As stated earlier, video signals in the standard commercial EIA format which do not include synchronization pulses are routed directly from any one of the ATM television cameras to any one of the two ATM monitors. A sync generator is included in this system to provide horizontal and vertical drive signals to each camera and monitor of the system, thereby synchronizing the overall system. The output video signal of the portable camera has the standard commercial EIA format. Therefore, a new circuit would be required to extract the sync pulses from the video signal output of the portable camera and to generate the necessary horizontal and vertical drive signals for proper operations of the ATM monitor in addition to any conditioning of the video signal which may be required. The camera selector switch for each monitor of the ATM closed circuit television system would have to modified to include another position to accommodate this new application of the

monitors. In addition to connecting the video signal from the portable camera to the ATM monitor, operation of this switch selector must also connect the monitor to the proper source for the necessary horizontal and vertical drive signals.

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